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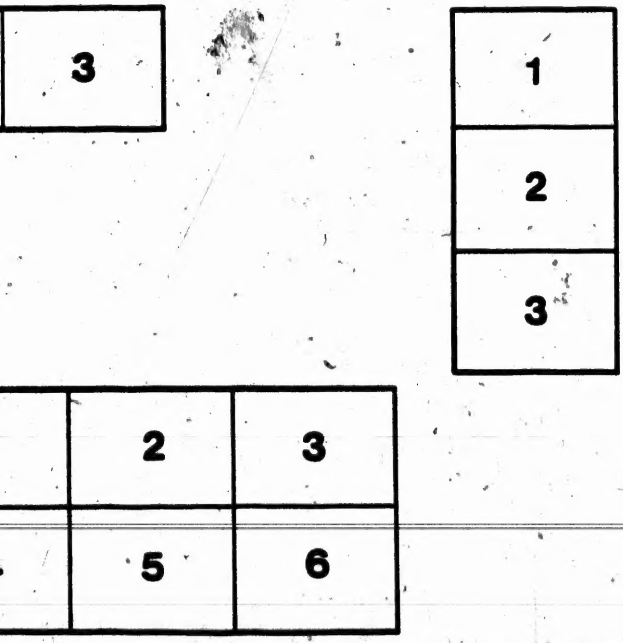

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THE IRON ORES OF NOVA SCOTIA.

By Edwin Gilpin, Jr., A.M., F.G.S., F.R.S.C., Etc.

Chief Inspector of Mines, N.S.

To be read on Thursday, 20th November.

The presence of iron ore in Nova Scotia was reported as early as 1604 by DeMonts, who found in the trap of Digby County veins of iron ore and in the beaches of St. Mary's Bay layers of magnetic iron ore sand. It does not, however, appear that any attention was paid by the early settlers to the deposits, as was the case in Canada, where reference is found as early as 1672 to the iron mines and foundries of St. Maurice. This may have been due, however, to the incessant wars and changes of government which filled the early pages of Acadian history. It was not until the early part of the present century that any attempt was made to utilise these ores. During its first decade a few tons of bar iron were made in a Catalan forge at Nictaux. Haliburton, in his History of Nova Scotia, gives an account of the next attempt, which was made at Moose River. It was under the auspices of a company incorporated by the Local Legislature in 1825, and one of the earliest of those now entitled as of "limited liability." The works produced an excellent charcoal iron which was largely cast into kettles and stoves, and some bar iron, but ran only for a short time.

After an interval of thirty years the furnace were started again for a short time and are now in ruins.

In 1828, the General Mining Association of London, the owners of the Albion Collieries of Pictou, collected a large lot of the limonite boulders, and mined some of the red hematites of the East River of Pictou, and experimented with them at the Albion Mines in a small furnace with unsatisfactory results.

In 1856 two small blast furnaces were built at Nictaux, Annapolis Co., and run on the fossil ores of the vicinity and some bog ore with chargoal, but were soon abandoned, and allowed to fall out of repair.

In 1850 a Catalan forge was put up at Londonderry, Colchester Co., and ran for three years. It was succeeded by a charcoal furnace in 1853, which ran until 1874, and produced about 45,000 tons of pig iron. The iron made from the excellent limonite ore of that locality was of the best grade. Sir William Fairbairn spoke of it in the highest terms, as possessing in an unusual degree the qualities adapting it for the manufacture of ordnance.

Steel was made from this iron to a limited extent, and proved equally satisfactory, the drills being largely used in the construction of the Intercolonial R.R. The remoteness of the works, however, from facilities for transportation retarded their development. The construction of the Intercolonial Railway, which was diverted from its course so as to pass near them, gave a chance for enlargement which was taken advantage of.

In 1873, the Steel Company of Canada acquired these works, and their great freehold property of over 55 square miles of land. Dr. Siemens, the distinguished metallurgist, was at the head of the Company, and great anticipations were entertained of a large and remunerative manufacture of steel. About two and a half millions of dollars were expended in building two large blast furnaces, and the plant necessary for an output by a direct process designed by Dr. Siemens. Rolling mills, forges, tramways, etc., were built, and the East and West Mines systematically opened, and a colliery developed at Maccan in Cumberland County. The enterprise, however, although producing an excellent grade of product, was not successful, the writer is informed, owing to the steel producers not proving satisfactory, and the attention of the Company was directed to car wheels, axles, nail plate, castings and pig iron.

The Company finally was reorganised under the title of The Londonderry Iron Company, Ltd., and is at present being successfully conducted under the management of Mr. R. G. Leckie. Further details of the operations of the Company will be given.

During the past few months the New Glasgow Iron Coal and Railway Company, operating at New Glasgow in Pictou County, have started to develop the ores of that locality, and their enterprise is being watched

with much interest, as, in the event of the production of a cheap steel and iron, there is no doubt that New Glasgow will become an important centre of ship building, bridge and locomotive works, etc.

NOTE.—Fuller details about the history of iron smelting in Nova Scotia can be found in Dawson's Acadian Geology, Haliburton's History of Nova Scotia, and Bartlett's Manufacture of Iron in Canada (American Institute of Mining Engineers, 1885).

The different geological horizons met in the province present iron ores under varied conditions of deposition, size, and composition. The following table shows the ores characterising the horizons, and is based on the reports of Sir William Dawson and the Canadian Geological Survey.

Geological Age.		*Variety of Ore found.*
Modern.		Bog Ore.—Iron sand.
Traissic	Sandstone.	Magnetic, Specular.
	Trap.	Magnetic, Specular.
Carboniferous.	Permo Carboniferous.	Clay Ironstone.
	Upper Coal Measures.	Clay Ironstone.
	True Coal Measures.	Black band, Clay Ironstone.
	Marine Limestone.	Clay Ironstone, Spathic. Limonite, Red Hematite.
	Lower Carboniferous.	Red Hematite.
Devonian, Oriskany Sandstone, etc.		Red Hematite, Magnetite, Spathic Ore, Specular.
Upper Silurian	Clinton.	Red Hematite.
	Lower Helderburg.	Red Hematite.
Lower Silurian.		Red Hematite, Magnetite.
Cambro Silurian.		Specular, Limonite.
Laurentian.		Red Hematite, Specular.

It may be remarked that the limonites and red hematites of the Marine Limestone and Lower Carboniferous are frequently found as contact deposits, or filling junction veins. The Lower Carboniferous horizon is represented in this province chiefly as black shales or conglomerates, and the Marine Limestone as alternations of shale, sandstone, limestone, marls, and gypsum. At numerous points these measures are found to carry contact deposits of iron ore where they rest on pre-Carboniferous strata. These deposits therefore occur between Carboniferous measures and Silurian, Laurentian and Devonian measures, the iron depositing agency being apparently inherent in the former.

In the table it will be noticed that all the divisions of the Carboniferous carry clay ironstones. These deposits, except in one instance to be noticed, do not as yet appear to be of economic value, but have not hitherto received any special attention. The Institute will observe that I have not included the gold-bearing strata of Nova Scotia referred to, the Lower Cambrian or Longmynd series of Europe among the ferriferous measures.* These measures, consisting almost entirely of slates and quartzites with an occasional calcareous sandstone, do not appear to have had the organic or seismological conditions permitting of the accumulations of iron ores. Discoveries of ores have been reported in these measures, but the writer is not aware that any are of economic or mineralogical interest. As the Atlantic front of the province is occupied by these rocks and their associated granites, the iron ores are confined to the more northerly part of Nova Scotia, and form a broad band extending from Digby in the west to Guysboro in the Straits of Canso, and through the Island of Cape Breton.

For the sake of conciseness the writer will take the ores in order as they are met in passing from east to west. In the Island of Cape Breton the two predominating series are Carboniferous and Laurentian. In the former there are met at numerous points layers of clay ironstone up to six inches in thickness. Samples from Schooner Pond and Barasois are said to yield from 25.84 to 27.89 per cent. of metallic iron. Near the top of the Lower Carboniferous at Sydney is a bed of marl, calcareous at several points, and carrying a sandstone in places containing 30 per cent. of metallic iron as a peroxide of iron.

At Big Pond, Ben Eoin, Red Island, Loran and several other places on the Bras d'Or Lake, where these measures rest on the Laurentian filsites, etc., are found contact deposits of red hematite. Some of these have been tested, and at several points a few tons of ore extracted, and they are believed to be of considerable extent, but have not yet been systematically mined. The ore occurs in veins and in pockets, frequently apparently replacing limestones or marly shales, and is often observed for considerable distances. On Boulardrie Island spathic iron ore occurs in a bed about three feet thick, carrying 32.58 per cent. of metallic iron. Bog ores are met at Boisdale, Schooner Pond and at several other points. Samples submitted to the writer appear to be of fair quality.

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* Note. See the Nova Scotia Gold Mines, by E. Gilpin, Am. Inst. M. E., 1886.

At George's River there is a narrow band of Lower Silurian measures extending across to Escasoni in East Bay. The slates and sandstones of this series are in places literally "soaked" with peroxide of iron. The mineral in places is segregated into beds or veins. Openings made by Mr. I. Greener at George's River show two deposits from five to ten feet wide, and apparently continuous for several hundred yards. A bed of red hematite which measured twelve feet in width has been exposed at Smith's Brook, East Bay.

It is, however, in the next horizon, that of the Laurentian, that the most important iron ore deposits of this Island will probably be found. These strata are divisible into two groups, the felsitic and the calcareous; the latter also having felsites, gneisses, etc. This division appears to be markedly ferriferous, and at two localities important red hematite and magnetite deposits are known. At Whycocomagh these two varieties occur in close proximity. Nine distinct beds are said to have been discovered and partly tested. They vary in thickness from three to nine feet. A five-foot vein of unusual purity has recently been opened here by Judge Tremaine. Near Gillies Lake, East Bay, the Moseley iron ore bed has been traced for about 2½ miles, and varies in thickness from four to thirteen feet. It is closely connected with crystalline limestones, and it is believed that there are other similar beds in the vicinity. Near the Indian Reserve and at Peter's Mountain near St. Peter's, in rocks of Devonian age, are found several veins of specular ore. These deposits have not yet been systematically examined, but are promising and close to shipping. They resemble in quality and manner of occurrence the Guysboro ores, to be noticed. Their iron contents appear to run from 50 to 60 per cent. At points considerable quantities of sulphur are visible, but large portions of the veins are composed of very fine ore. Iron ores are also known near Lake Anslie, Mabou, Cheticamp, Hunter's Mountain, Craignish, Grand Anse, Loch Lomond, etc., but no attention has yet been paid to them.

The following table will serve to show the composition of some of these ores. It may be remarked that, judging from their quality as tested by superficial openings and samples, they should furnish some very good ores for steel making, and, as they are nearly all near deep water, they should be available for exportation. Other deposits again are lower in iron and higher in posphorus, but would be rich enough for consumption in local furnaces.

	Loch Lomond.	East Bay.	East Bay.	Whycocomagh.	Whycocomagh.	Lorne.	Big Pond.	George's R.
Metallic Iron	64.49	59.63	57.92	48.25	60.90	63.09	61.39	62.50
Silica	7.76	5.13	12.80	24.78	10.80	5.46	9.04	7.82
Phosphorus	.03	—	—	tr.	tr.	—	tr.	.02
Sulphur	.07	.07	trace	tr.	tr.	.10	tr.	tr.
Phosphoric Acid	—	.03	.16	—	—	.11	—	—
Alumina	—	—	1.56	2.72	1.49	—	—	—
Magnesia	—	—	.60	1.08	1.64	4.20	1.22	.88
Lime	—	—	1.20	1.18	1.85	—	—	.67
Water	—	—	1.30	1.30	—	—	1.53	1.10
Manganese	2.85	—	.26	—	—	—	—	—
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

Analysis.
(1) Geo. Sur. Can.
(2) Geo. Sur. Can.
(3) Steel Co. of Canada.
(4) Dr. Howe.
(5) Dr. Howe.
(6) Geo. F. Downing.
(7) Geo. Sur. Can.
(8) E. Gilpin.

Passing to Nova Scotia proper, the first ores met are those of the Devonian of Guysboro County. In strata of this age in Annapolis County are known the valuable bedded hematites, sometimes altered into magnetites, of Clementsport and the Nictaux district. In Guysboro County, however, important deposits have been opened, and their mode of occurrence has a direct bearing upon the probable ore-yielding localities on the opposite side of the Strait of Canso. At Erinville is a large and important deposit of specular ore. Some years ago a test was made of the extent of this deposit. A shaft was sunk in the ore fifty feet, and a tunnel driven, exposing a body of ore sixty five feet wide; another bed in the vicinity was twelve feet wide. The ore is fairly compact, running from 55 to 62 per cent. of metallic iron, and very low in phosphorus, and not holding above the amount of sulphur usually found in ore of this character. The walls of the veins are composed of greenish, dioritic, felspathic, trappean, brecciated rock. About a mile further west, promising indications of ore have been found in altered slates, and shales with quartz. In the vicinity are large masses of dark gray trap, in contact with conglomerate.

At Boylestown, on the east side of Milford Haven, are a series of veins of specular ore from two to four and a-half feet wide, in shale, with calcite. These deposits are connected with dioritic rocks as at Salmon River Lakes. A few tons were mined and found of good quality, but the expense of transport to the Londonderry furnaces, their only market, proved too great.

At Polson's Lake, Antigonish Co., are found lenticular masses of spathic ore, in some cases associated with copper sulphides, and beds of limestone carrying considerable amounts of carbonate of iron. A limonite from this locality yielded on analysis

Iron 48.00.	Phosphorus tr
Water 11.12.	Sulphur tr.
Manganese oxides 4.73	Magnesia tr.
Silicious matter 3.86	

Passing to the northern part of the County, among the Lower Silurian metamorphic rocks, which form a broad band extending from the head waters of the East River of Pictou to Cape St. George, there are found abundant traces of specular, limonite, hematite and magnetite.

At Arisaig, on Doctor's Brook, are important deposits of hematite. One bed is six feet thick, overlaid by another said to be twelve feet thick, and underlaid by thinner beds. On the road from Doctor's Brook to Pleasant Valley is a six feet bed, and a twenty four feet bed, and other deposits occur in this locality. The ore is oolitic and in many places of good quality. Little work has yet been done to determine the extent and nature of these ores. They occur in connection with reddish and mottled fragmentary rocks, diorite with [illegible] of epidote, red concretionary and hematitic slate and similar rocks, and perhaps owe their origin to the proximity of syenite, diorite and other igneous rocks. At Arisaig Brook is a bed of red hematite one to three feet thick, oolitic, and fossiliferous. This ore is referred to by Mr H. Fletcher as apparently belonging to the Niagara. The only analysis of an ore from this district that has come under the writer's notice gave 52.34 per cent. of metallic iron, but was high in silica and phosphorus. These ores could be shipped at Arisaig, if further researches prove them to be available for export. They could doubtless be smelted at present with charcoal as there are large tracts of woodland in the vicinity.

PICTOU COUNTY.

The accompanying map shows the position of Pictou Harbour in relation to the coal, limestone, and iron ores of the County. Geologically speaking, the district may be described as made up of Carboniferous resting on Silurian and Cambro Silurian. The two horizons of the Carboniferous most interesting in this connection are the middle coal measures at New Glasgow forming the "Pictou" coal fields, and the Carboniferous foundation carrying numerous beds of limestone. As the basal conglomerate of shales if the Carboniferous is sparingly met in this district, the limestones may be compared to a fringe around the pre-Carboniferous, and lying between the coal and iron ore deposits. The iron ore district may be roughly described as a triangle formed by the ore outcrops and the Intercolonial and Cape Breton Railways, the former marking the base and the latter the sides of the triangle, having its apex in the coal field at New Glasgow. The construction of a railway has been begun to bisect the base, following the course of the East River.

From Arisaig to Sunny Brae in the East River of Pictou there extends a band of Silurian measures which have been extensively studied by Sir W. Dawson and the late Dr. Honeyman, and are shortly to be illustrated by the map of the Geological Survey under Mr. Fletcher. In this connection the most important horizons are perhaps the

Lower Helderberg, Niagara, and Clinton. Although veinlets, and indications of iron ore abound in this range west of the deposits just referred to, it is not until French River is reached that evidences are presented of any attempt to ascertain the value of the iron contents of these horizons, which are in Nova Scotia proper classed as the principal homes of the ores of this important metal. There is doubt that when the demand arises there will be found at numerous points in this apparently barren interval deposits of iron ore at least equal to those characterizing it at Arisaig and on the head waters of Sutherland's and the East River.

The chief ore of this formation is a bedded red hematite found in four principal deposits. The most northerly of these, distant about two miles from the Pictou Coal field, is known as the Fall Brook, or Watson ore. It has been opened by a few trial pits, and found in Fall Brook to be about fifteen feet wide, and to maintain this size for about a mile to the eastward.

The next bed, known as the Webster ore, has been carefully trenched and tested at several points. Its thickness varies from fifteen to thirty feet, its dip being generally north at angles varying from 25 to 60 degrees.

At two points it presents the following sections :—

	ft.	in.
Ore	4	4
Smooth parting	0	0
Ore	3	0
Slate	2	11
Ore	3	3
Total	13	6

	ft.	in.
Ore (in four layers)	3	0
Smooth parting	0	0
Ore	2	6
Smooth parting	0	0
Ore	3	0
Slaty ore	3	10
Ore	6	10
Total	20	4

This ore follows the crest of a high hill cut transversely by the valley of Sutherland's River, and admits of adit drainage to a depth of 300 feet. The ore is compact, non-fossiliferous, and brick red when weathered.

The third exposure is known as the Blanchard Great Bed.

No attempts have yet been made to trace it beyond the natural exposures, which extend about half a mile. It varies in width from 30 to 100 feet measured across a dip nearly vertical. It is also situated on elevated ground, and would yield a large amount of ore.

At a geological horizon about 700 feet higher than the last mentioned bed is a conformable range of red hematites forming the fourth series. This ore appears, as shown on the map, to form a synclinal trough. On the west side the ore is twelve feet thick, and at the apex there appear the outcrops of two other beds, eight and three feet in thickness, the larger possibly representing the great bed. On the east side of the synclinal only one bed has been opened, varying in width from three to five feet. Underlying this bed, and on the line where the great bed would show its eastern outcrop, are large boulders precisely similar in appearance to the one on its western outcrop, and it is expected that it will shortly be found there.

It is considered by some geologists that the three large single beds were originally one, and owe their present disjointed condition to faults and erosion; no detailed survey, however, has been made to prove the correctness of this opinion, and at present it can only be said that they are apparently contained in a limited vertical range of strata.

The outcrops of other red hematites have been marked on the map, but no work has been done to allow of details being given.

These red hematites are all of the same class, being of a red color, with earthy to steely lustre, compact or laminated, sometimes oolitic owing to the peroxide forming minute concretions around grains of sand. In places these ores contain fossils, but the larger proportions are quite free from them.

Similar ores, called fossil red hematites, are found in Pennsylvania in strata of the Clinton age, and extensively worked near Tyrone for mixture with rich hematites and magnetites. For comparison an analysis of one is given, made at the University of Pennsylvania :—

Sesquioxide of Iron	38.48
Peroxide of Iron	4.37
Silica	37.99
Alumina	9.56
Lime	1.08
Alkalies	2.89
Phosphoric Acid	1.48
Sulphur	trace
Volatile	4.50
Metallic iron	30.34

These ores are in firm and compact strata, and should be mined very cheaply as little timbering would be needed, and the measures will be found dry below water level. Although their contents of metallic iron are not equal to those of the other deposits, their cheapness proximity to coal and immense extent will make them important items in iron-making in this county.

Passing to the west side of the East River there extends from Sunny Brae to a point about six miles west of Glengarry Station a belt of strata comprised principally of black and grey slates and quartzites. They have been considered to be the Eastward Extension of the Axial measures of the Cobequid Mountains (carrying the Londonderry iron ores), and are termed provisionally Cambro Silurian. In the district lying west of Glengarry Station there are numerous exposures of specular ore up to three feet in thickness. The ore occurs as veins, usually conformable but sometimes traversing the strata. At one point about two miles west of Glengarry there is a large vein of ankerite with calc-spar carrying several bodies of specular ore. The quality of the ore as exposed by trenches is frequently excellent, at other points it is mixed with vein matter.

So little, however, has yet been done to test their size and economic values that no definite information can be given. From Glengarry westward to Drug Brook, a tributary of the west branch of the East River, traces of specular ore are found, but no deposit has been exposed in site. At this point there are natural exposures showing three beds of limonite, the thickest thirty inches in width. Some distance south of this in the West Branch Lake is a vein of limonite about two feet thick. It is not yet settled if the ore at Drug Brook represents that met near Glengarry, and possibly it belongs to a second ore range lying to the south of the specular. This vein is strengthened by the fact that limonite occurs further east to the south of the specular.

From the Drug Book westward for about three miles traces of specular ore are met. At this point, in an area owned by Mr. S. H. Holmes, an opening has been made on a specular vein seven feet wide. The ore eastwardly to the East River the passage of the specular ore vein has been traced and several openings made. The vein is, strictly speaking, a stratum vein, and has a course agreeing closely with that of the slates, and a nearly vertical dip. Its width is from 50 to 150 feet, and the ore bodies run in width from one to twenty feet. The principal openings have been made on areas held by Messrs. Holmes and Bartlett. At the point where the vein approaches the river there are indications, that it carries limonite as well as specular, and as already mentioned, there is a body of limonite lying about a quarter of a mile to the south, and said to be about six feet wide. The ores are found along the crests of the hills bordering the river valley, and admit of considerable adit mining, and should be easily drained. They are compact and foliated, and of good quality. The principal impurities observed in the ore is sulphur, but it appears to be confined in a small compass at a few points, and is presumably due to some agency of faults later in date than the formation of the ore vein, and the remaining portions of the veins are free from it.

Along the valley of the East River above Springville the Lower Carboniferous marine formation rests upon the Silurian, the actual unconformable contact being visible at several points. So far as explorations have been carried, there appears to be a junction fracture or series of faults.

These seem to have become receptacles for numerous deposits of an excellent limonite ore. The ore occurs in the Carboniferous and in the older slates as either horizon was faulted, and along the junction. For a distance of about eight miles extending down the river from Sunny Brae, there are numerous exposures of ore. At several points the bodies are over twenty feet wide. The mining operations initiated by the New Glasgow Iron, Coal and Railway Co. during the past few months have shown that the deposits maintain their size in depth. At several places the ores are highly manganiferous, and from one opening about 100 tons of manganese ore of excellent quality was extracted. The limestones which are found in close connection with the limonite are frequently highly ferruginous and manganiferous, and specimens have been found showing that spathic ore also occurs in this valley of the East River. At the point where the west branch crosses the junction of the Carboniferous and Cambro Silurian drift limonite has been observed, but no search has been made for it.

The ore of this valley is compact, concretionary and fibrous, with considerable quantities of gravel ore. At two points the ore has been noticed to rest on the Silurian clay slates, and has limestone on the hanging walls, with a gore of red clay, frequently holding concretions of manganite and pyrolusite intervening. These ores are very pure and free from phosphorus, the average of five analyses giving .118 phosphoric acid, or .083 of phosphorus in 100 parts of iron.

The belt holding ore is 800 yards wide at several places as shown by surface indications, and it appears probable that there is a large amount of it in the valley.

The limonite may have been derived, like the limonite of Cumberland Co. and other localities in Pennsylvania, as a residual precipitate from the disseminated iron sand grains of the Upper Silurian strata, as well as a deposit from the gradual dissolution of the marine limestone. In view of this it may be stated that in this district the rocks of both ages contain considerable quantities of iron as carbonate and peroxide, and that the erosion has been on an enormous scale.

Passing to the Sutherland's River district, an opening has been made on a bed of spathic ore which occurs in red marl, associated with limestone and gypsum. Its width varies from six to ten feet, and from surface indications it appears to extend over a considerable trac. of country. The bed in places is highly manganiferous, and is a typical spathic iron, granular and crystalline in texture, and of a light grey colour. The following analyses will show its character.

	I.	II.
Sesquioxide of Iron	20.52	——
Carbonate of Iron	57.40	82.11
Carbonate of Manganese	8.29	4.70
Carbonate of Lime	4.02	2.37
Carbonate of Magnesia	5.66	9.06
Silica	2.38	1.69
Moisture	1.13	——
Sulphur	none	.10
Phosphorus	none	none
Metallic Iron	42.07	39.64

I. Dr. T. S. Hunt. II. J. H. Huxley.

Indications of spathic ore have been found on Sutherland's River, McLellan's Brook, etc., under similar conditions, and this ore may prove a wide-spread and important addition to the ores of the county. Still further east on French River, at a horizon apparently several hundred feet higher, and considered to represent the upper part of the marine limestone formation, there are several beds of a nodular red hematite, varying in thickness up to four feet. These beds have been recognised as extending for several miles. They appear to be the weathered outcrops of carbonate ores, but they have only been examined superficially. Samples taken from the outcrop of a four foot on French River yielded 35 per cent. of metallic iron.

In the productive coal measures, clay, ironstone and black band ores have been noticed at several horizons. It may be questioned if any of the ores hitherto casually exposed in shafts and stone tunnels are present in quantities large enough to warrant the expectation of independent workings, although in some cases they could be worked in connection with the coal beds. The following analyses by the writer will serve to show the quality of some of these ores:—

	I. Clay Ironstone.	II. Black Band.
Moisture	2.132	——
Sulphur	.612	.214
Phosphoric Acid	trace	.386
Manganese Oxide	——	4.450
Lime	trace	3.780
Magnesia	4.655	.783
Alumina	16.962	3.180
Silica	.780	16.546
Carbonic Acid	——	27.589
Iron Protoxide	45.361	36.000
Metallic Iron	35.000	28.000

Although no attempts have yet been made to find iron ore in the coal districts the indications observed up to the present date may fairly be considered to show the probable presence of a large and cheap supply of ore.

In the Upper Carboniferous measures lying to the north of New Glasgow there are several thin layers of clay ironstone not apparently of economic value.

In the surface drift there have been beds of bog iron ore observed at numerous points. These deposits have nowhere been observed of large dimensions, but would probably be utilised for furnace purposes in the vicinity of the iron ore districts more particularly alluded to above.

ANALYSES OF PICTOU IRON ORES.

	Specular.		Limonite.		Red Hematite.		
	1	2	3	4	5	6	7
Oxides of Iron	92.01	64.63	97.51	83.09	81.19	70.00	65.26
" Manganese	.16	2.74	—	1.10	.20		trace
Alumina	.21	2.95	—	—	—	—	5.59
Carbonate of Lime	1.27	.041	—	.01	.67	3.03	1.08
" Magnesia	.43	.046	—	—	—	—	1.05
Phosphoric Acid	.08	.031	—	—	.15	.20	—
Sulphur	.16	trace	.06	.04	trace	—	—
Silica	3.88	17.89	3.20	1.80	4.26	25.92	25.68
Metallic Iron	64.41	44.82	68.33	65.20	56.83	45.17	43.1

1. Dr. Macadam
3, 4, 7, Dr. T. E. Thorpe. 5, 6, 8 H. Hussey.

River John, French and East rivers may be mentioned as localities yielding this ore; and the following analysis by the writer is of ore from a small bed exposed in a cutting of the Glasgow and Cape Breton Railway in Merigomish near French River.

Moisture	5.500
Water of Composition	6.100
Sulphur	.208
Phosphoric Acid	.384
Manganese Oxide	5.886
Lime	trace
Magnesia	trace
Alumina	3.106
Silica	12.325
Iron Peroxide	66.510
Metallic Iron	46.557

At Newton Mills, Upper Stewiacke, the New Glasgow Coal, Iron and Railway Co. have opened an important deposit of red hematite, occurring in connection with measures provisionally referred to the Upper Silurian. The slates connected with the deposit are in places rich enough to work as ore. It is believed that further search will show a valuable deposit here.

A working sample gave:—

Peroxide of Iron	60.380
Phosphorus	.018
Sulphur	.164
Lime	.340
Alumina	6.640
Silica	27.970
Manganese and Magnesia	trace
Alkali	2.690
Water	1.310
Iron	42.27

In Hants County, on the west and east sides of Grand Lake, where the Lower Carboniferous measures rest on the Lower Cambrian (Carboniferous measures), there are pockets of red hematite of excellent quality. Little attention has yet been paid to the locality, which may prove important, as the ores, if present in quantity, are rich enough to ship via Halifax for export to the United States, and would be about 80 miles from New Glasgow and Londonderry.

These ores are similar in quality and mode of occurrence to those found at the contact of the Carboniferous and Laurentian at numerous points in Cape Breton already referred to. At Brookfield, about 8 miles south of Truro, a mine has been opened on a large vein of limonite, in places over twenty feet wide. Shipments have been made by rail to Londonderry, and it is probable that it will be largely drawn upon for the proposed furnaces in Pictou County. The ore is of good quality, some of it being almost chemically pure. It is about thirty-five miles by rail from Londonderry and fifty miles from New Glasgow. At Goshen, between Windsor and Truro, a vein of ankerite containing limonite has been opened in strata of the marine limestone age, and proved to be forty feet wide. The following analysis of the ore is interesting from the amount of manganese present. In connection with this ingredient it may be stated that considerable quantities of manganite and pyrolusite have been mined and exported from this district.

Metallic Iron	35.10
Oxide of Manganese	24.74
Alumina	3.68
Lime	.35
Magnesia	4.76
Silica	4.81
Iron Pyrites	.20
Phosphoric Acid	.21
Water	11.10
100 of Iron contain	.26 Phosphorus.

At the mouth of the Shubenacadie River the lowest visible Carboniferous bed is a dark laminated limestone which, with the overlying sandstones and marl, contains small veins holding limonite and specular ore, with ankerite, barite, calcite, gothite, manganite and siderite. In the same formation, a few miles to the eastward of Clifton, similar ores are found. At this point they are of more importance, one of the limonite veins being six feet wide.

At Selina, to the west of the Shubenacadie River, a compact red hematite occurs. A partial test made by the New Glasgow Coal, Iron and Railway Co. shows eight feet of ore. Further work will, it is expected, show an important deposit.

The ore resembles very closely and can hardly be distinguished from choice Lake Superior red hematite. The deposit is in measures of Lower Carboniferous age, but does not appear, so far as work has been carried, to be a contact deposit. The following analysis of averages will show its quality:—

Silicious matter	12.610
Phosphorus	.037
Sulphur	.020
Iron	46.[illegible]

At Mount Thom, in Colchester County, drift boulders of specular ore were found last summer by the New Glasgow Coal and Iron Co., and openings made on what appears to be the parent vein, and at Kemptown, on the easterly prolongation of the Londonderry vein, an important deposit of limonite was found, and is now being proved. Working samples yielded:—

Iron	53.040
Phosphorus	.112
Sulphur	.022
Silica	7.490

On the upper waters of the North River of Truro magnetite occurs in a vein three feet thick, and is of good quality.

The Nova Scotian, or southern side of the Bay of Fundy is girt by a wall of dioritic trap, with ash, lying upon and connected with sandstones referred to the Triassic period. At numerous points this trap holds veins of magnetite and specular, and not unfrequently the soil derived from it holds limonite as the outcome of a secondary process. Usually the veins are irregular and small, the largest deposit which has come under the writer's notice being near Digby, and from eighteen inches to two feet in width. The magnetite is frequently massive, sometimes crystallised in partly filled veins, and associated with quartz, colourless and amethystine. It is usually pure, the principal foreign substance being silica. The ore also occurs disseminated in the trap at numerous points in small grains, sometimes only recognizable when separated by the magnet from the pulverized rock. At a point near Digby Neck it is associated with specular ore, and often tons were shipped some years ago.

The following analyses will show the characters of these ores:—

	I.	II.	III.
Iron	60.430	49.291	68.33
Silica	14.320	26.872	5.46
Phosphorus	.036	.031	—
Sulphur	.046	.021	—
Titanic iron	trace	trace	—
Magnesia	—	—	1.27

Digby Neck, Granville, Margaretville, Malvern are among the localities where surface indications appear to warrant a belief that workable deposits exist.

Red hematite occurs in a similar manner associated with quartz, agate, and calcite. It is sometimes presented in the form of small crystalline plates, in a granular quartz matrix, and sometimes as crystals, apparently showing its derivation from the magnetite. Specimens are met, especially the more highly crystalline ones, having decidedly magnetic properties. These ores are frequently met throughout the trap range, which is 120 miles in length.

Titaniferous iron ore is found at St. Mary's Bay, west of Digby, as sand forming irregular layers in the beach. The indications are said to be extensive, but no attempts have been made to test its value for working.

A sample yielded:—

Magnetic Iron Sand or Iserine	30
Non-magnetic or ilmenite	56
Silicious sand	14
	100

Both varieties containing a large amount of titanium and a little magnesia. This ore is reported from Shelburne and other points on

the Atlantic Coast, and from Musquodoboit, near Halifax; that from the latter place being a dark micaceous schist, holding crystals of magnetite with titanium in considerable quantity. The writer has also observed a similar ore near Sutherland's River, in Pictou County, holding titanium. So far these ores have not been much prized by the metallurgist. Attempts were made a number of years ago to smelt similar ores at Bay St. Paul, on the north shore of the Gulf of St. Lawrence, but were abandoned chiefly, it is said, owing to the fuel charges. The pig made was white and of fair quality. There are, however, on the northern shores of the Gulf and in Newfoundland deposits of magnetites apparently free from this ingredient, and they may prove an important aid to the iron smelting operations in Pictou County. South of the long range of trap referred to, is a narrow fertile valley traversed by the Annapolis and Cornwallis valleys, and underlaid by Triassic sandstones. On the south side of the valley a band of strata, referred by Sir William Dawson to the Devonian, succeeds the sandstones. This band varies in width from three to six miles, and is known to extend from Digby to a point a few miles west of Windsor, and is divided into two nearly equal parts by a mass of granite. In the Western part are the Clementsport ores, in the eastern those of the Nictaux district.

At Clementsport there are two beds of ore running nearly east and west, and underlying to the south at nearly vertical angles. The highest of these beds is known as the Milner deposit, and varies in thickness from two to four feet. It is a specular ore, metamorphosed with magnetic properties, and retains casts of virclibite, spirifers and associated molluscks. The ore, which is of fair quality, yields about 33 per cent. of metallic iron, and has been mined by open cast work. The underlying or Potter bed may perhaps be classed as a magnetite, and the former workings presented the following section:—

	ft.	in.
Ore	3	0
Slate	2	6
Ore	3	6
	9	0

It is compact and dark gray in colour. The writer has seen no analysis of it, but it has been reported as running low in phosphorus and yielding 48 per cent. of iron.

At Bloomfield and several other points in this vicinity are beds of bog ore, yielding about 25 per cent. of iron. It is found a few inches under the surface, in layers from six inches to two feet in thickness. Reference has already been made to the furnace built here, and details of its size, etc., are without interest in this connection. The fuel was charcoal, and the daily yield from a mixture of ore from the various openings was five tons.

At Nictaux, 37 miles east of Clementsport, an attempt was made a number of years ago to work similar ores. The ore was taken from a bed of highly fossiliferous peroxide of iron associated with dark gray slates, which has been traced about four miles, and varies in thickness from three to four and a-half feet.

The fossils of the red hematite and associated beds are spirifer, areuosus, strophemena, magnifica, and depressa, Atrypa unguiformis, and species of Aricula, Bellerophon, Farosites and Zaphrentis, etc., compared by Professor Hall with the fauna of the Oriskany sandstones, and proving the beds to be of Lower Devonian age. There is also found in these measures a bed of gray magnetic ore about eight feet wide. Several other deposits of ore have been found at Torbrook, and considerable amounts have been shipped by Mr. Leckie to his furnaces at Londonderry. These newer openings yield a good ore, and the beds vary in thickness up to eight feet. The following analysis will show their quality:—

	Magnetite. I.	Red Hematite. II.
Metallic Iron	59.11	57.93
Sulphur	.09	.036
Phosphorus	.17	.16
Alumina	5.53	—
Lime	2.70	—
Magnesia	.41	—
Silica	14.97	17.21

The ores of this district appear to have been originally red hematites or peroxides, but they have lost more or less of their oxygen and become magnetic. Specimens can be got showing the gradual change from normal red hematites with cherry red powder, to magnetic ores with brown or black streaks. This is probably a local metamorphism due

to the presence of organic matter and the granitic dykes which traverse the works in the vicinity.

The writer has received specimens of limonite, red hematite, and bog ore from the district lying to the south of the Devonian band, and extending east nearly to Windsor, a distance of fifty miles. As yet these ores are not known in amounts of economic value, but no search has yet been made for them, and as the Silurian, Arisaig, horizons probably exist here important discoveries may be anticipated.

CONDITIONS UPON WHICH IRON ORE LANDS ARE GRANTED.

The following is a brief outline of the conditions under which minerals other than gold and silver, owned by the Provincial Government, are granted.

A license to search for eighteen months can be secured for $30.00, covering five square miles. Before the expiration of the license to search a lease of one square mile can be selected on the payment of $50.00. This runs for twenty years, an annual rental of $50.00 being paid unless work is performed, and is renewable. A royalty of five cents a ton is levied on all coal sold or smelted. The law also provides that any land required for mining purposes may be secured by arbitration.

There are many localities in the Province where the land grants made previously to 1869 conveyed the iron ore also. These mineral properties in this respect belong to the owner of the soil, and are not liable to the Government royalty.

LONDONDERRY. The mineralogical and geological relations of the ferriferous strata here have been fully described by Sir Wm. Dawson and Dr. Selwyn. It may be remarked that running along the southern plank of the Cobequid Mountains there is a band of strata, referred by some writers to the Cambro Silurian period, carrying for a distance of many miles a stratum vein composed of carbonates and oxides of iron, with carbonate of lime and magnesia. Situated on elevated ground, cut transversely by deep ravines, this vein has as yet been inappreciably worked. Its width varies up to two hundred feet, and ore bodies of limonite have been found in it over fifty feet wide. There are also immense masses of spathic ore, and at some points the vein carries ankerite. At present, mining operations are confined principally to the limonite, but from this date more attention will be paid to the spathose ores, which will yield on calcining a valuable furnace material. There are two mines, known as the East and West mines, connected by railway with the furnaces standing between them, about three miles from Londonderry Station, on the Intercolonial Railway. These mines give employment to about 100 miners, who are housed by the company. There are two furnaces, the one now being put in blast having a height of 75 feet, 19 feet bosh, and a nine feet hearth, and will, it is expected, yield 100 tons of pig a day. The other furnace is 62 feet high, with 19 feet bosh, and 7 feet hearth, and will probably be altered to correspond with the more productive dimensions of its mate. Two gas calcining kilns, of a capacity of one hundred tons each day, are being built to calcine the spathic ore which has the following composition :—

Iron	40.60
Silica	1.60
Volatile	32.8

and would yield upon calcination about 60 per centum of iron. Some of this ore enriched by veinlets of specular runs as high as 59 per cent. of iron. The following analysis from the reports of the Canadian Geological Survey will serve to show the quality of the other ores:—

	Limonite.	Hematite.
Peroxide of Iron	82.65	96.93
Oxide of Manganese	.25	—
Alumina	.56	.33
Lime	.15	.04
Magnesia	.10	.11
Phosphoric Acid	.18	.007
Sulphuric Acid	.12	.03
Water	10.71	.82
Insoluble	4.79	1.26
Metallic Iron	57.85	67.85

A small quantity of ankerite has been used as a flux and yields :—

Carbonate of Lime	51.61
Carbonate of Magnesia	28.69
Carbonate of Iron	19.57
Insoluble	.13
	100.00

The Brookfield limestone which is used for flux, and resembles a compacted heap of recently opened and cleaned shells, is remarkably free from sulphur and phosphorus, as shown by the following analysis:—

Lime Carbonate	97.39
Magnesia Carbonate	.94
Oxide of Iron	2.70
Phosphoric Acid	none
Insoluble residue	trace

About 35,000 tons of charcoal pig were made here during the early history of the establishment, the following analysis of which is by Took, Esq.:—

Carbon	3.50
Silica	.84
Sulphur	.02
Phosphorus	.19
Manganese	.44
Iron	94.85

The indications are that this vein will continue for many years to come to yield a supply of excellent ore equal to the demands of an establishment much larger than the present one.

The coke used here is made from coal from the Intercolonial and Albion mines, Pictou county, and from the Spring Hill mines, and varies somewhat in ash percentages from 15 to 20 per cent. The coke in other respects is hard, and free from deleterious substances. An attempt is now being made to work the lower portion of the Albion Main Seam, Pictou county, which yields an excellent furnace coke. The coal gives on analysis:—

Ash	9.00
Volatile matter	27.65
Fixed Carbon	63.35

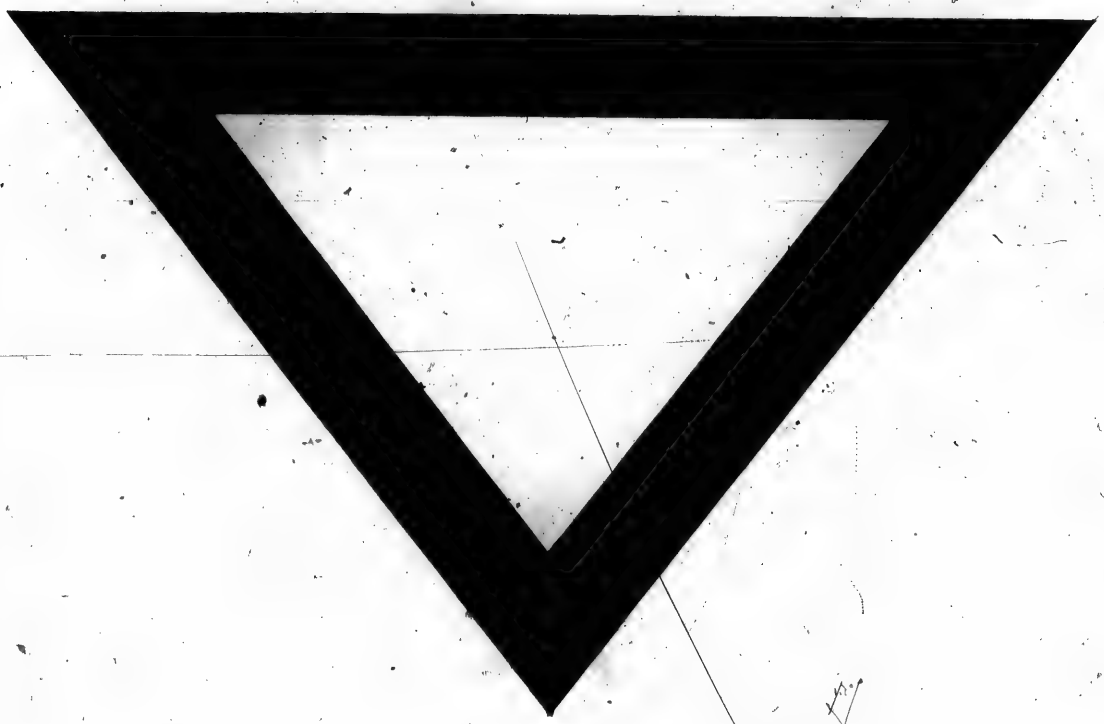
And the coke shows:—

Ash	13.1
Volatile matter	3.0
Fixed Carbon	83.9

The furnaces are fitted with blowing engines, hot blast stoves, lifts, ore sheds, etc., substantially built and of modern pattern. In addition there are:—

Rolling mill:—

8 double puddling furnaces.
1 single " " "
Horizontal squeezer and rolls.
18 inch train of rolls.
16 " do do
9 " do do
2 steam hammers.
5 heating furnaces.

Capacity of mill, 8,000 tons a year.
do blast furnace, 2,000 tons yearly
do do do under construction, 35,000 tons a year.

Pipe foundry, 6,000 tons a year.